VERIFICATION OF TRANSLATION

I, Jung-Hwan Song of 1451-34 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare as follows:

1. I am well acquainted with both the English and Korean languages.

2. The following is a true translation made by me to the best of my knowledge and belief of Korean Patent Application No. 2004-15693.

Dated the 29th day of July 2009

송 정 환

Jung-Hwan Song

[ABSTRACT]

[ABSTRACT]

The invention provides an electron beam irradiator capable of performing electron beam irradiation in a wide area at a high current density with a field emitter tip. The electron beam irradiator comprises: a vacuum chamber having a beam irradiation window formed longitudinally in an outer periphery of the vacuum chamber; a cathode placed centrally and longitudinally inside the vacuum chamber, and having a field emitter tip formed on the cathode, corresponding to the beam irradiation window; and a high voltage supply placed at one end of the vacuum chamber, and adapted to apply high voltage toward the cathode.

According to the invention, electron beam irradiation can be made in a wide area without using an electromagnetic as well as in a high current density without using a heater such as a filament or an additional power supply, thereby to ensure a simplified structure as well as a reduced size.

[REPRESENTATIVE DRAWING]

Fig. 1

[INDEX]

electron beam irradiator, carbon nanotube, vacuum chamber, cathode

[SPECIFICATION]

[TITLE]

A LARGE-AREA SHOWER ELECTRON BEAM IRRADIATOR WITH FILED EMITTERS AS AN ELECTRON SOURCE

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is an exploded perspective view illustrating an electron beam irradiator according to an embodiment of the invention;

FIG. 2 is a cross-sectional view illustrating an assembled state of the electron beam irradiator shown in FIG. 1;

FIG. 3 is a cross-sectional view illustrating an electron beam irradiation pattern according to the invention;

FIG. 4 is an exploded perspective view illustrating an electron beam irradiation window according to the invention;

FIG. 5 is a cross-sectional view illustrating an assembled state of the electron beam irradiation window shown in FIG. 4;

FIG. 6 is a perspective view illustrating an electron beam irradiator according to another embodiment of the invention;

FIGS. 7a to 7c illustrate electron beam irradiation patterns from the electron beam irradiator as shown in FIG. 6 according to the invention, in which

FIG. 7a is an illustration of a plurality of beam irradiation windows provided according to the invention, in which independent irradiation is performed,

FIG. 7b is an illustration of beam irradiation windows provided at three sides according to the invention, in which multiple irradiation is performed onto an object moving on a curved surface, and

FIG. 7c is an illustration of beam irradiation windows provided at four sides according to the invention, in which multiple irradiation is performed onto the inside surface of a cylindrical object.

[DETAILED DESCRIPTION]

[TECHNICAL FIELD]

The present invention relates to an electron beam irradiator, and more particularly, a low-energy electron beam irradiator designed to allow electron beam irradiation in a wide area without using a scanning magnet system as well as in a high current density without using a heater such as a filament or an additional power supply, thereby to ensure a simplified structure as well as a reduced size.

As well known to those skilled in the art, the property of every substance is determined by the bonding of component atoms, in which the bonding is carried out by outer electrons bound to the atoms. Changing the bonding status of a substance with electron beams of a sufficiently energy level can obtain a property totally different from the previous one can be realized.

That is, electron beams may be irradiated to a substance to give an additional available property to it or to remove any property, for example, harmful to the human from it.

A cathode material used in an electron beam irradiator to generate electron beams is generally selected from various single crystals, oxides and so on that has a low work function. However, these materials are restricted in their size to use an e-beam irradiator sources, and thus the use of an electromagnet is necessary in order to give electron beams irradiation and treatment to an object in a wide area.

Besides, conventional electron beam irradiators are of thermoelectric actuation type in which a cathode material is heated with a filament up to a suitable high temperature in order to produce electron beams. This as a result essentially needs an additional separate power supply to be used together with the filament.

As described above, conventional electron beam irradiators have a complicated structure. Besides, since conventional electron beam irradiation is carried out

with a point electron beam source, there are drawbacks in that irradiation efficiency degrades and economic competitiveness and workability become poor.

Accordingly, an electron beam irradiator capable of preventing the above problems has been required in the art.

[THE OBJECT OF THE INVENTION]

The present invention has been made to solve the foregoing problems of the prior art and it is therefore an object of the present invention to provide an electron beam irradiator designed to irradiate electron beams in a wide area without using an electromagnet system as well as in a high current density without using a heater such as a filament or an additional power supply, thereby to ensure a simplified structure as well as a reduced size.

It is another object of the invention to provide an electron beam irradiator designed to irradiate electron beams radially from a strip-shaped field emitter tip of a cathode allowing a larger area to be irradiated at a wider area, thereby further improving the irradiation efficiency of electron beams.

It is further another object of the invention to provide an electron beam irradiator designed to be simply assembled and disassembled thereby enhancing the promptitude, simplicity and efficiency of assembly, substitution and maintenance.

It is other object of the invention to provide an electron beam irradiator designed to minimize the distortion of an accelerated electric field of electron beams irradiated through a beam irradiation window while preventing the vacuum state of a vacuum chamber from damage through the beam irradiation window as well as to achieve a sufficient enduring force against the pressure difference between the vacuum and the air while minimizing the thickness of a metal foil through which the electron beams are irradiated thereby to decrease the loss of the electron beams and resultant energy loss through the metal foil.

It is yet another object of the invention to provide an electron beam irradiator designed to form several beam irradiation windows in a single cylindrical unit in order to ensure independent application and high operation efficiency for the respective beam irradiation windows according to use, further raise treatment efficiency for the inside of a cylindrical object in particular, and enable current density adjustment according to the distance change between the irradiator and the object.

[EMBODIMENTS OF THE INVENTION]

According to an aspect of the invention for realizing the above objects, it is provided an electron beam irradiator comprising: a vacuum chamber having a beam irradiation window formed longitudinally in an outer periphery of the vacuum chamber; a cathode placed centrally and longitudinally inside the vacuum chamber, and having a field emitter tip formed on the cathode, corresponding to the beam irradiation window; and a high voltage supply placed at one end of the vacuum chamber, and adapted to apply high voltage toward the cathode.

Preferably, the field emitter tip is made of a carbon nanotube.

In the invention, the cathode is of a rod-shaped structure having a circular cross-section, and includes a field emitter tip shaped as a strip formed longitudinally in an outer periphery of the rod-shaped structure.

The electron beam irradiator may further comprise: fixing flanges integrally provided at both ends of the vacuum chamber; a first vacuum flange coupled with one of the fixing flanges, and having a high voltage supply; a second vacuum flange coupled with the other one of the fixing flanges; a first support including a pin insert hole formed at one end of the cathode and a first insulator formed in the high voltage supply for the passage of a connector pin of the high voltage supply so that the connector pin is inserted into the pin insert hole of the cathode through the first insulator; and a second support

including an insert groove formed in a second insulator longitudinally and axially in a central portion of the second vacuum flange so that an insert protrusion formed at the other end of the cathode is inserted into the insert groove to support the cathode.

In the invention, the beam irradiation window may comprise: a base plate fixed to the vacuum chamber, slightly protruded from the vacuum chamber to the outside, and having an elongated rectangular slit formed in a central area thereof; a metal wire inserted into an insert groove formed in an outer periphery of the slit of the base plate; a metal foil placed on the metal wire, and having an area slightly larger than an area surrounded by the metal wire; and a cover plate coupled with the base plate, corresponding to the slit of the base plate, and having a beam irradiation slit corresponding to the slit in the central area of the base plate.

Preferably, the vacuum chamber is cylindrical, with a plurality of beam irradiation windows formed in an outer periphery thereof, and wherein the cathode placed inside the vacuum chamber has field emitter tips formed in an outer periphery of the cathode, corresponding to the beam irradiation windows of the vacuum chamber, respectively.

Preferred embodiments of the invention will be described in more detail in oonjunotion with tho accompanying drawingc.

FIG. 1 is an exploded perspective view illustrating an electron beam irradiator according to an embodiment of the invention, as will be described hereinafter.

As shown in FIG. 1, the electron beam irradiator of the invention includes an electrically-anodic vacuum chamber 1, which is adapted to keep the inside in vacuum, a cathode 2 centered longitudinally inside the vacuum changer 1 and having a rod shaped structure 2A, first and second supports 3 and 4 supporting both ends of the cathode 2 inside the vacuum changer 1, respectively, and a high voltage supply 5 for applying high voltage to the cathode 2.

The vacuum chamber 1 may be of a cylindrical structure with opening at both ends, and has an elongated beam irradiation window 11 formed in a substantially middle area in the outer periphery of the cylindrical structure. In addition, first and second fixing flanges 12 and 12A are formed integral with the both ends of the vacuum chamber 1.

The cathode 2 is shaped as an elongated rod with a circular cross section. A field emitter tip 20 shaped as an elongated strip is formed on the cathode 2, opposed to the beam irradiation window 11 in the vacuum chamber 1. The field emitter tip 20 is preferably made of carbon nanotubes 20A.

Carbon nanotubes were found by Dr. Iijima Sumio of NEC Corporation's Fundamental Research Laboratory in 1991 when he was analyzing carbon solids grown on a graphite cathode by using electric discharge, in which hexagons of six carbon atoms are connected together into the shape of a tube having a diameter on the order of merely from several to several tens of nanometers. This is also called as a field emitter tip. In addition, nanometer as 1/1,000,000,000m is substantially equal to 1/100,000 of a human hair.

Carbon nanotubes exhibit electrical conductivity as high as copper, thermal conductivity as high as diamond, which has been known having the most excellent strength in the nature, and strength 100 times greater than steel. Carbon nanotubes can endure up to 15% deformation whereas carbon fibers are cut at merely 1 % deformation. In the invention, carbon nanotubes are adopted as an electron beam irradiator.

The high voltage supply 5 of the invention is adapted to hermetically seal the both openings of the vacuum chamber 1 as well as apply high voltage to the cathode 2. The electron beam irradiator of the invention includes a first vacuum flange 51 coupled with the first fixing flange 12 of the vacuum chamber 1 and a second vacuum flange 6 fixed to the second fixing flange 12A of the chamber 1 in order to hermetically seal the vacuum chamber 1 from the outside. The vacuum flanges 51 and 6 are sealed through bolt fastening.

Besides, in the electron beam irradiator of the invention, the first and second supports 3 and 4 are adapted to support the cathode 2 at both ends thereof inside the vacuum chamber 1. The first support 3 includes a pin insert hole 31 formed at one end of the cathode 2, as shown in FIG. 2, for receiving a connector pin 52 protruded from the high voltage supply 5 therein so as to provide electrical connection to the cathode 2 while supporting them in position. The first support 3 has a first insulator 32 shaped to surround the connector pin 52 and made of insulation ceramic. The first insulator 32 has a pin through hole 321 in a central portion thereof, which allows the passage of the connector pin 52 of the high voltage supply 5. The outer surface of the first insulator 32 is screwed into a mounting groove 33 provided in an insulator 5a of the high voltage supply 5. This insulation structure ensures that high voltage flowing along the connector pin 52 is positively, electrically insulated from other components other than the cathode 2.

The second support 4 includes a coupling groove 45 formed in a central portion of the second vacuum flange 6 and a second insulator 41 with a coupling protrusion 44 in its rear end. The rear coupling protrusion 44 is adapted to be spirally coupled with the coupling groove 45. Besides, the second insulator 41 has an insert groove 42 formed in a front central portion thereof, and the cathode 2 has an insert protrusion 43 to be inserted into the insert groove 42 and supported therein.

In addition, it is preferable that a number of prominences and depressions are formed in the surface of the first and second insulators 32 and 41 extending surface passages thereof in order to prevent insulation breakdown under high voltage.

FIG. 2 is a cross-sectional view illustrating an assembled state of the electron beam irradiator shown in FIG. 1, as will be described hereinafter.

In the electron beam irradiator of the invention, the cathode 2 is provided

longitudinally in a central portion of the vacuum chamber 1, in which one end of the cathode 2 is connected with the high voltage supply 5 by the first support 3 and supported in position thereby, whereas the other end of the cathode 2 is connected with the second vacuum flange 6 by the second support 4 and supported in position thereby. The one end of the cathode 2 is supported as the connector pin 52 of the high voltage supply 5 is inserted into the pin insert hole 31 of the cathode 2 through the first insulator 32 of the firs support 3, and the other end of the cathode 2 is supported as the rear insert protrusion 43 of the cathode 2 is inserted into the insert groove 42 of the second insulator 41.
The connector pin 52 is electrically connected to a power supply (not shown) via the high voltage supply 5 so that high voltage supplied from the power supply is applied to the cathode 2. In the electron beam irradiator of the invention structured as above, when high voltage is applied to the cathode 2, the field emitter tip 20 provided opposite to the beam irradiation window 11 of the vacuum chamber 1 emits electron beams of high current density via field emission. Since the cathode 2 has a circular cross-section and the field emitter tip 20 is formed along the curve of the circular cross-section, electron beams are radially generated as shown in FIG. 3.
The electron beams are then accelerated with a predetermined energy between the vacuum chamber 1, electrically acting as an anode, and the cathode 2, such that the accelerated electron beams are irradiated through the beam irradiation window 11 of the vacuum chamber 1.

FIGS. 4 and 5 illustrate the electron beam irradiation window equipped in the electron beam irradiator of the invention, as will be described hereinafter.
The electron beam irradiation window 11 is provided in the vacuum chamber 1, and has a base plate 111 formed in an elongated, substantially rectangular opening of the vacuum chamber 1. The base plate 111 is integrally protruded from the vacuum chamber 1. An elongated rectangular slit 111A is formed in a

central portion of the base pin 111, and a substantially rectangular wire insert groove 111B is formed in the outer circumference of the slit 111A, by which a metal wire 112 is received in the base plate 111.

A thin metal foil 113 is seated on the metal wire 112, and a cover plate 114 is placed on the metal foil 113 and coupled with the base plate 111 via bolt fastening. In a central portion of the cover plate 114, a beam irradiation slit 114A having a shape matching that of the slit 111A of the base plate 111.

The base plate 111 is preferably designed to protrude at a minimum dimension in order to decrease the distortion of an accelerated electric field. The metal wire 112 acts as a seal to prevent the vacuum inside the vacuum chamber 1 from being lost through the beam irradiation window 11.

In the beam irradiation window 11 equipped in the electron beam irradiator of the invention structured as above, the thin metal foil 113 can positively withstand the pressure difference between the vacuum and the air since the slit A in the base plate 111 has a small width. This as a result can relatively increase the quantity of electron beams penetrating the metal foil 113 over those of penetrating a thick metal foil, thereby decreasing energy loss. So, advantageously, the beam irradiation window 11 can act as a suitable beam irradiation window for low energy electron beams.

FIG. 6 is a perspective view illustrating an electron beam irradiator according to another embodiment of the invention. As shown in FIG. 6, the electron beam irradiation of the invention has a plurality of beam irradiation windows 11 around a vacuum chamber 1. Also, a cathode 2 is provided longitudinally, centrally inside the vacuum chamber 1, and has a plurality of field emitter tips 20 matching the beam irradiation windows 11, respectively.

As shown in FIG. 7a, with the beam irradiation windows 11 formed at both sides of the vacuum chamber 1, the electron beam irradiator of the invention can provide treatment to objects while they linearly move along arrows outside the vacuum chamber 1. Also, as shown in FIG. 7b, with the three beam

irradiation windows 11 provided at three sides of the vacuum chamber 1, the electron beam irradiator can provide treatment to an object which linearly moves around the beam irradiation windows 11 in the direction of an arrow. In addition, as shown in FIG. 7c, the four beam irradiation windows 11 formed at four sides of the vacuum chamber 1, the electron beam irradiator of the invention can provide treatment to a cylindrical object while being rotated in the direction of an arrow inside a cylindrical object.

It is to be understood that while the present invention has been illustrated and described in relation to several potentially preferred embodiments, such embodiments are illustrative only and that the present invention is in no event to be limited thereto.

[ADVANTAGEOUS EFFECTS]

As described above, the present invention provides an electron beam irradiator designed to irradiate electron beams in a wide area at a low energy by using field emitter tips so that electron beams can be irradiated in a wide area without using an electromagnet as well as in a high current density without using a heater such as a filament or an additional power supply, thereby ensuring a simplified structure as well as a reduced size.

Also, according to the invention, the electron beam irradiator, by using electron beams emitted from strip-shaped field emitter tips formed in a cathode, can rapidly cure ink or paint applied in a wide area as well as facilitates massive disinfection and sterilization of medical articles.

Besides, according to the invention, the electron beam irradiator can be simply assembled and disassembled thereby enhancing the promptitude, simplicity and efficiency of assembly, substitution and maintenance.

In addition, according to the invention, the electron beam irradiator can minimize the distortion of an accelerated electric field of electron beams

irradiated through a beam irradiation window while preventing the vacuum state of a vacuum chamber from damage through the beam irradiation window as well as to achieve a sufficient enduring force against the pressure difference between the vacuum and the air while minimizing the thickness of a metal foil through which the electron beams are irradiated thereby to decrease the loss of the electron beams and resultant energy loss through the metal foil.

Furthermore, according to the invention, the electron beam irradiator can form several beam irradiation windows in a single cylindrical unit in order to ensure in-dependent application and high operation efficiency for the respective beam irradiation windows according to use, further raise treatment efficiency for the inside of a cylindrical object in particular, and enable current density adjustment according to the distance change between the irradiator and the object.

[CLAIMS]

1. An electron beam irradiator comprising:

a vacuum chamber having a beam irradiation window formed longitudinally in an outer periphery of the vacuum chamber;

a cathode placed centrally and longitudinally inside the vacuum chamber, and having a field emitter tip formed on the cathode, corresponding to the beam irradiation window; and

a high voltage supply placed at one end of the vacuum chamber, and adapted to apply high voltage toward the cathode.

2. The electron beam irradiator according to claim 1, wherein the field emitter tip is made of a carbon nanotube.

3. The electron beam irradiator according to claim 1, wherein the cathode is of a rod-shaped structure having a circular cross-section, and includes a field emitter tip shaped as a strip formed longitudinally in an outer periphery of the rod shaped structure.

4. The electron beam irradiator according to claim 1 or 3, further comprising:

fixing flanges integrally provided at both ends of the vacuum chamber;

a first vacuum flange coupled with one of the fixing flanges, and having a high voltage supply;

a second vacuum flange coupled with the other one of the fixing flanges;

a first support supporting one end of the cathode, the first support including a first insulator through which a high voltage supply pin of the high voltage supply is inserted into a pin insert hole formed at one end of the cathode; and

a second support supporting the other end of the cathode, the second support including a second insulator having an insert groove into which an insert protrusion formed at the other end of the cathode is inserted.

5. The electron beam irradiator according to claim 1, wherein the beam irradiation window comprises:

a base plate fixed to the vacuum chamber, slightly protruded from the vacuum

chamber to the outside, and having an elongated rectangular slit formed in a central area thereof;

a metal wire inserted into an insert groove formed in an outer periphery of the slit of the base plate;

a metal foil placed on the metal wire, and having an area slightly larger than an area surrounded by the metal wire; and

a cover plate coupled with the base plate, corresponding to the slit of the base plate, and having a beam irradiation slit corresponding to the slit in the central area of the base plate.

6. The electron beam irradiator according to claim 1 or 3, wherein the vacuum chamber is cylindrical, with a plurality of beam irradiation windows formed in an outer periphery thereof, and wherein the cathode placed inside the vacuum chamber has field emitter tips formed in an outer periphery of the cathode, corresponding to the beam irradiation windows of the vacuum chamber, respectively.

[DRAWINGS]

FIG. 1

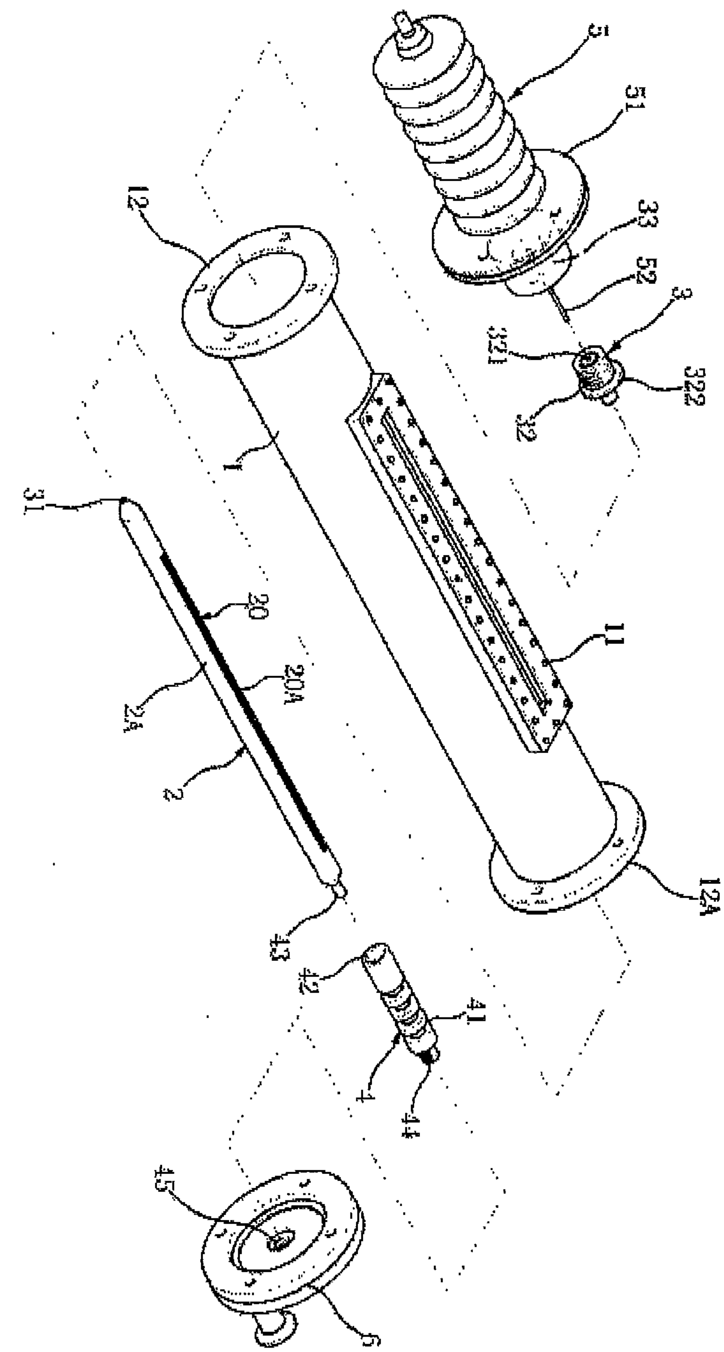

FIG. 2

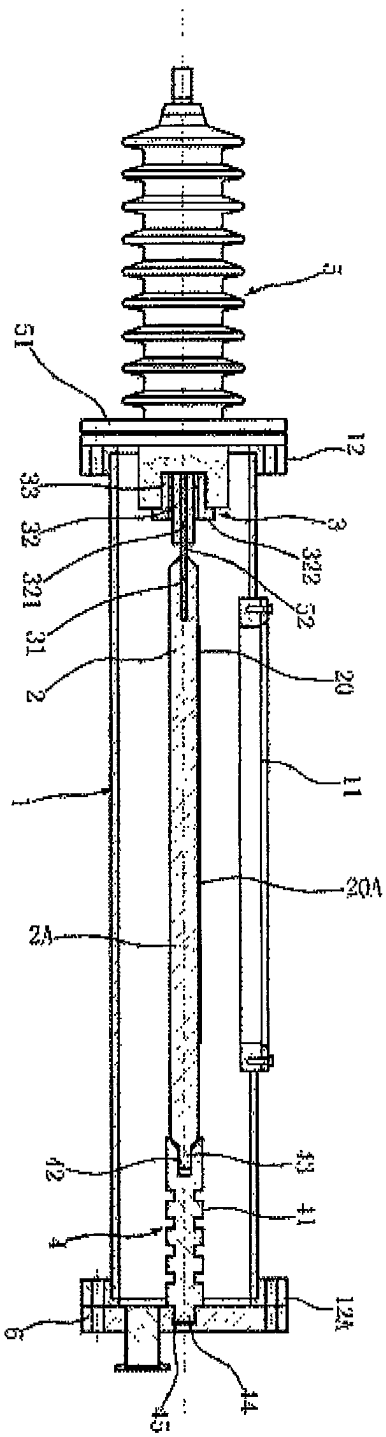

FIG. 3

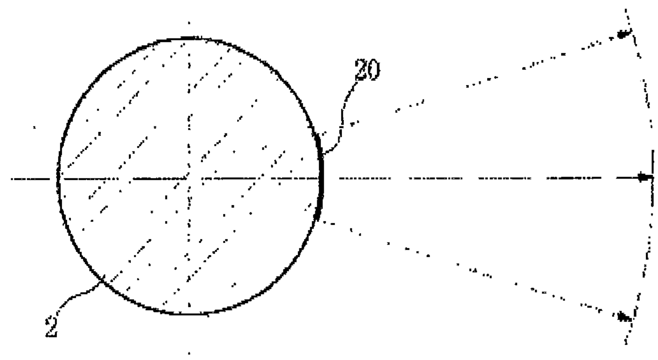

FIG. 4

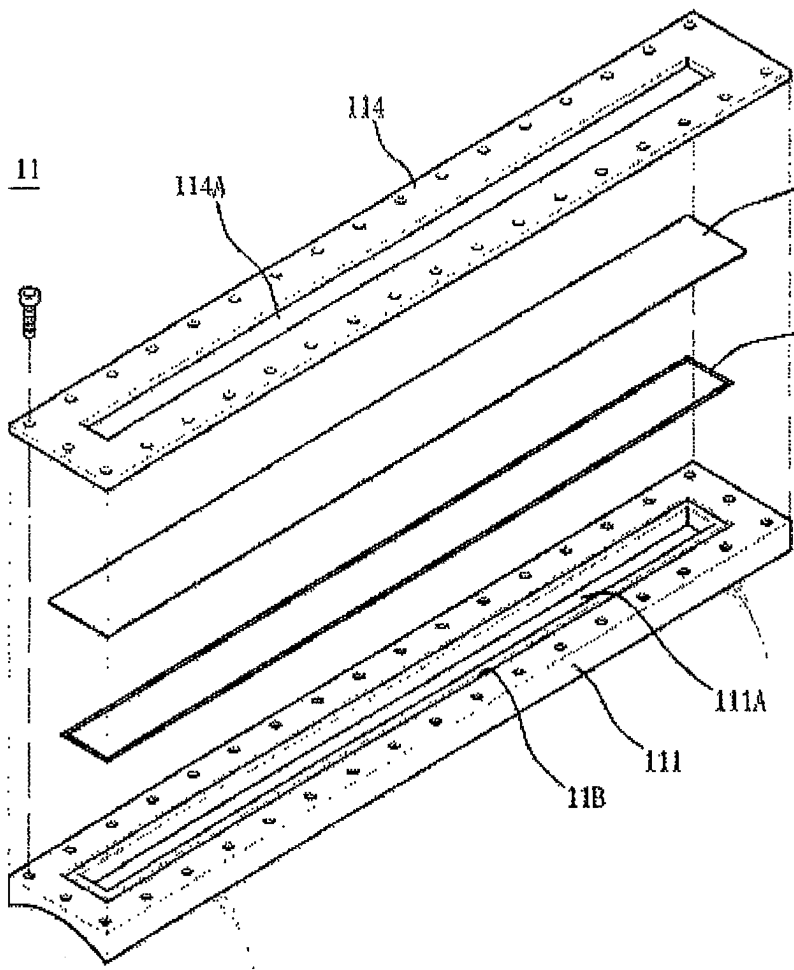

FIG. 5

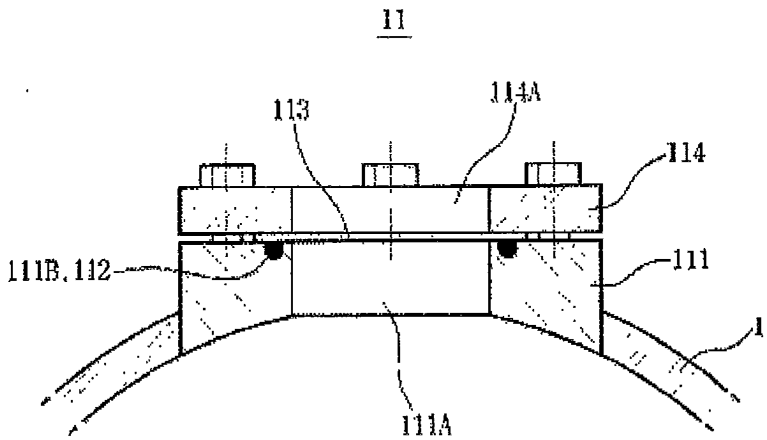

FIG. 6

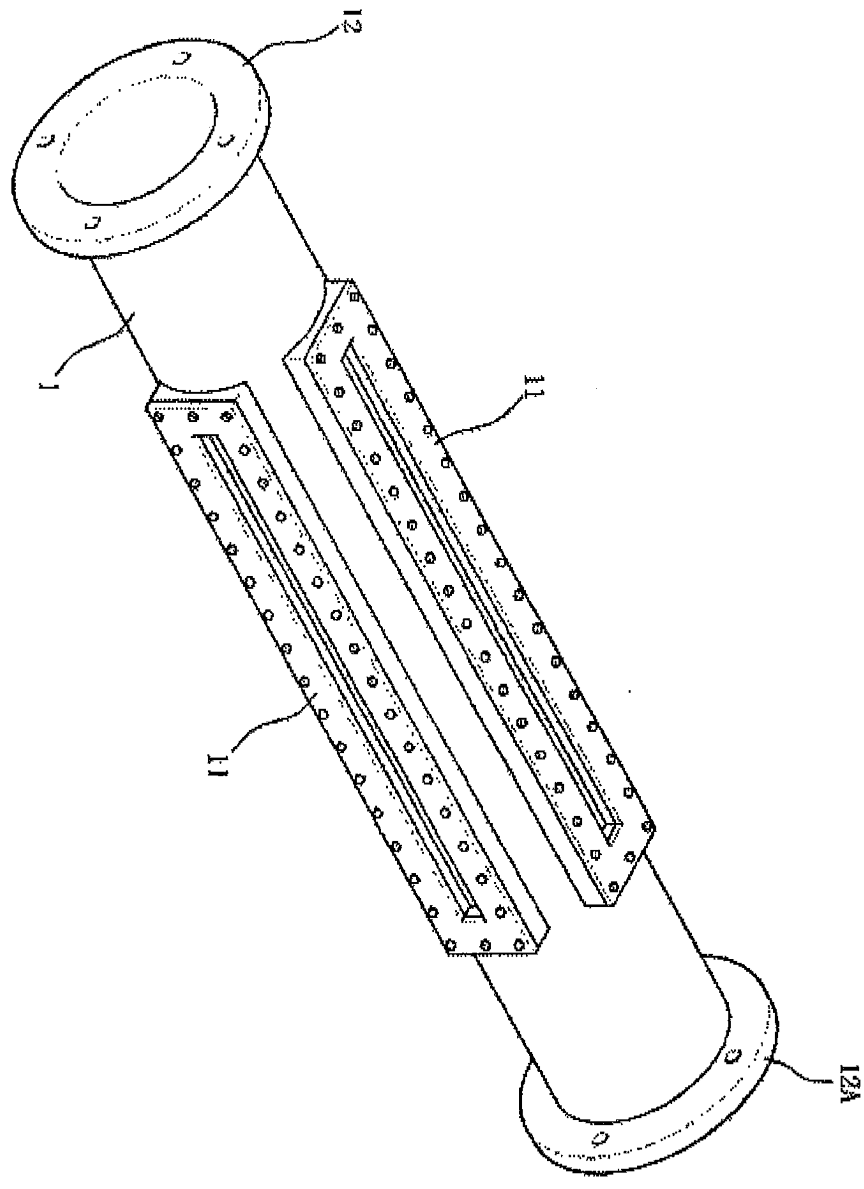

FIG. 7a

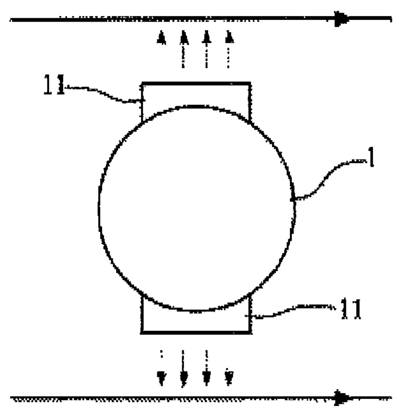

FIG. 7b

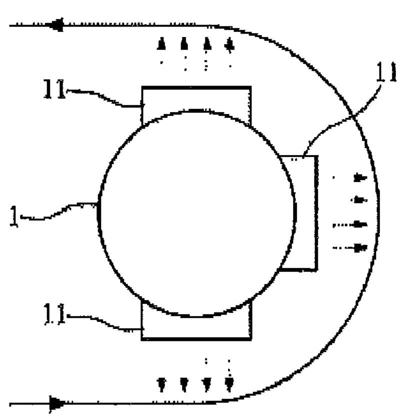

FIG. 7c